

**Title:      Hollow Fiber Module**

**Patent Claims**

1. A hollow fiber fluid separation module having an inlet (20) for an inlet feed flow, an outlet (22) for an exit flow, an access port (26) for a permeate flow, a discharge port (28) for the permeate flow, a module axis (30) and a plurality of hollow fibers, each of said fibers extending from said inlet (20) to said outlet (22) and comprising an interior communicating with said inlet (20) at one end of each hollow fiber and with said outlet (22) at the other end of each hollow fiber, with the hollow fibers being wound in multiple layers (40, 42, 44) to form a hollow cylindrical coil, each layer (40, 42, 44) being defined on its inner side by an imaginary cylinder (35, 36, 37) and having a number of hollow fibers helically wound on said cylinder (35, 36, 37) with a helix angle  $\alpha$ , said fibers being in a clearance relationship with each other and equally spaced on said cylinder, with one layer (e.g., 40) differing from a neighbouring layer (e.g., 42) by the fact that all the fibers of the one layer are inclined at the wind angle plus  $\alpha$ , whereas all the fibers of the neighbouring layer are at the wind angle minus  $\alpha$ , each fiber being wrapped  $360^\circ$  at least once around the associated cylinder and being laid down during winding with a tensile strain high enough for the fiber to be frictionally held in the best possible manner to the crosswise disposed fibers lying underneath and low enough for the hollow fibers not to have their inner cross section noticeably restricted even though they are deformed at the intersections and for all of the hollow fibers to be applied with the same tensile strain.
2. The hollow fiber fluid separation module as set forth in claim 1, characterized in that the first, lowermost layer (40) is located on a tube (32) that forms the imaginary cylinder of said layer (40).
3. The hollow fiber fluid separation module as set forth in claim 1, characterized in that the access port (26) comprises at least one axial bore (29) that is formed in the tube (32).

4. The hollow fiber fluid separation module as set forth in claim 1, characterized in that the wind angle  $\alpha$  ranges between  $15^\circ$  and  $75^\circ$ , preferably between  $20^\circ$  and  $70^\circ$  and more specifically is on the order of  $45^\circ$ .
5. The hollow fiber fluid separation module as set forth in claim 1, characterized in that the distance  $a$  between two hollow fibers of one layer ranges between onefold and tenfold the inner radius of the hollow fibers.
6. The hollow fiber fluid separation module as set forth in claim 1, characterized in that all of the fibers have the same length.
7. The hollow fiber fluid separation module as set forth in claim 1, characterized in that all of the fibers are built according to the same design principle.
8. The hollow fiber fluid separation module as set forth in claim 1, characterized in that the tensile strain is selected such that the free inner cross section of the hollow fiber at the intersections is more than 90 %, more specifically more than 95 % and advantageously more than 98 % of the inner cross section of the hollow fiber outside of the intersections.
9. The hollow fiber fluid separation module as set forth in claim 1, characterized in that the outermost layer of the winding is enclosed by a shell (34) that tightly surrounds said outermost layer and comprises access (26) or exit (28) means for permeate flow, more specifically for circulation gas.
10. The hollow fiber fluid separation module as set forth in claim 1, characterized in that the module is obtained from a preform by cutting the preform along the sectioning planes (52) and that the preform comprises an axially quite long winding and has an axial length that is greater than the length of a plurality of modules.